DIVE MANUAL VOL I Rev 3
RECORD OF CHANGES

CHANGE NO.	DATE OF CHANGE	TITLE OF BRIEF DESCRIPTION	ENTERED BY
1	15 Jul 96	Permanent Change One	
Errata for Change 1	3 Feb 97	Replacement Pages for Permanent Change One	
Diving Advisory 97-02 IC 1	3 Feb 97	BUMED Action Codes and telephone numbers and subspecialty codes for undersea medical officers	
Diving Advisory 97-06 IC 2	17 Mar 97	General guidance to assist activities in minimizing their risk and raising the awareness of divers to the inherent risks associated with the use of electricity underwater.	
Diving Advisory 98-03 IC 3	23 Jan 98	Clarifies diver air sampling program procedures and periodicity changes.	
Diving Advisory 98-04 IC 4	12 Mar 98	Remove NMRI as POC for 24–hour diving consultation and changes NEDU's area code to 850. (Note – This package includes deletion NMRI references on page 4-49, which were not specified in AIG 239/98-04.)	

DIVE MANUAL VOL II Rev 3
RECORD OF CHANGES

CHANGE NO.	DATE OF CHANGE	TITLE OF BRIEF DESCRIPTION	ENTERED BY
Diving Advisory 98-04 IC 7	12 Mar 98	Remove NMRI as POC for 24–hour diving consultation and changes NEDU's area code to 850. (Note – This is the first interim change after permanent change 3)	

Emergency Assistance Checklist

RECOMPRESSION CHAMBER

Location

Name/Phone Number

Response Time

GAS SUPPLIES

Location

Name/Phone Number

Response Time

AIR TRANSPORTATION

Location

Name/Phone Number

Response Time

COMMUNICATIONS

Location

Name/Phone Number

Response Time

SEA TRANSPORTATION

Location

Name/Phone Number

Response Time

DIVING UNITS

Location

Name/Phone Number

Response Time

HOSPITAL

Location

Name/Phone Number

Response Time

COMMAND

Location

Name/Phone Number

Response Time

DIVING MEDICAL OFFICER

Location

Name/Phone Number

Response Time

EMERGENCY CONSULTATION

Duty Phone Numbers 24 Hours a Day

Navy Experimental Diving Unit (NEDU)

Commercial (850) 230-3100

Autovon 436-4351

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Figure 4-21. Emergency Assistance Checklist

- The section on First Aid which includes Basic Cardiac Life Support (BCLS) has been moved to Appendix M. These procedures are constantly updated and this appendix should be kept as current as possible. Every diver shall maintain current American Heart Association (AHA) or equivalent certification in BCLS. This periodic refresher training on BCLS and first aid will not only keep the procedures in this annex up-to-date but will keep personnel sharp.

- A section on evaluating patients with decornpression sickness has been included. This will help to ensure that urgency is driven by the patient's condition and that guidelines are established for evaluating treatment outcome.

- The initial treatment for arterial gas embolism has been changed. A large body of research plus operational experience has shown that immediate recompression to 60 feet will be adequate for treating the vast majority of cases. Deeper recompression is carried out after initial evaluation at 60 feet shows the patient is not responding or is deteriorating and deeper recompression is needed.

- A change has been made to 0_2 breathing requirements for tenders on treatment tables.

- A new worksheet for evaluation of accident victims has been included in Appendix H. This worksheet should prove useful in ensuring that all pertinent information is collected regarding the cause and treatment outcome of accidents. Use of this worksheet is not mandatory; it is given as an aid.

It is important to realize that this chapter is a working document. While its procedures should be adhered to as closely as possible, any mistakes or discrepancies must be brought to the attention of NAVSEA immediately. There are instances where clear direction cannot be given; in these cases, the diving medical experts at NEDU should be contacted for clarification. **IC 4**

Chapter 8 is designed as a reference for individuals trained in diving procedures. It is also directed to users with a wide range in medical expertise, from the fleet diver to the Diving Medical Officer. Certain treatment procedures require consultation with a Diving Medical Officer for safe and effective use. In preparing for any diving operation, it is mandatory that the dive team have a medical evacuation plan and know the location of the nearest or most accessible Diving Medical Officer.

SECTION 8C

RECOMPRESSION THERAPY

Section 8C covers recompression therapy. Recompression therapy is indicated for the treatment of omitted decompression, decompression sickness, and arterial gas embolism.

The procedures outlined in this chapter are to be performed only by personnel properly trained to use them. Since these procedures cover symptoms ranging from pain to life-threatening disorders, the degree of medical expertise necessary to carry out treatment properly will vary. Certain procedures, such as starting IV fluid lines and inserting chest tubes, require special training and should not be attempted by untrained individuals. Treatment tables can be executed without consultation with a Diving Medical Officer, although a DMO must always be contacted at the earliest possible opportunity. Three treatment tables, however, require special consideration. Treatment Table 4 is a long, arduous table that requires constant evaluation of the stricken diver. Treatment Table 7 and Treatment Table 8 allow prolonged treatments for severely ill patients based on the patient's condition throughout the treatment.

Experience has shown that symptoms of severe decompression sickness or arterial gas embolism may occur following seemingly normal dives. This fact, combined with the many operational scenarios under which diving is conducted, means that treatment of severely ill individuals will be required occasionally when qualified medical help is not immediately on scene. Therefore, it is the Diving Supervisor's responsibility to ensure that every member of the diving team:

(1) Be thoroughly familiar with all recompression procedures.

2) Know the location of the nearest, certified recompression facility.

(3) Know how to contact a qualified Diving Medical Officer if one is not at the site.

Modern communications allow access to medical expertise from even the most remote areas. Emergency consultation is available 24 hours a day with:

Navy Experimental Diving Unit (NEDU)
321 Bullfinch Rd.
Panama City, FL 32407-7015
Commercial: (850)230-3100
Autovon: 436-4351

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The recompression procedures described in this chapter are designed to handle most situations which will be encountered operationally. They are applicable to both surface-supplied and SCUBA diving, whether on air, nitrogen-oxygen, helium-oxygen, or 100-percent oxygen. For example, the treatment of arterial gas embolism has little to do with the gas being breathed at the time of the accident. Since all possible conditions cannot be anticipated, additional medical expertise should be sought in all cases of decompression sickness or arterial gas embolism that do not show substantial improvement on standard treatment tables. Treatment of decompression sickness during saturation dives is covered separately in Volume 2, Paragraph 1223.3, of this manual. Periodic evaluation of

Recompression is not necessary unless symptoms develop.

Asymptomatic divers who blowup and who have missed decompression stops are treated by recompression based on the amount of decompression missed as follows:

- **Oxygen Available -** Immediately compress the diver to 60 feet in the recompression chamber. If less than 30 minutes of decompression (total ascent time from the tables) was missed, decompress from 60 feet on Treatment Table 5. If more than 30 minutes of decompression was missed, decompress from 60 feet on Treatment Table 6.

- **Oxygen Not Available -** Compress the diver to 100 feet in the recompression chamber and treat on Table IA if less than 30 minutes of decompression was missed; compress to 165 feet and treat on Table 2A if more than 30 minutes was missed.

As long as the diver shows no ill effects, decompress him in accordance with the treatment table. Consider any decompression sickness that develops during or after this procedure a recurrence. Try to keep all surface intervals as short as possible (five minutes or less). If an asymptomatic diver who blows up from a decompression dive has more than a five-minute surface interval, he is decompressed from 60 feet on Treatment Table 6 or treated on Table 2A, even if the missed decompression time was less than 30 minutes.

When no recompression facility is available, use the following in-water procedure to make up omitted decompression in asymptomatic divers for ascents from depths below 20 feet.

Recompress the diver in the water as soon as possible (preferably less than a five-minute surface interval). Keep the diver at rest, provide a standby diver, and maintain good communication and depth control. Use the decompression schedule appropriate for the divers depth and bottom time. Follow the procedure below with one minute between stops:

(1) Return the diver to the depth of the first stop.

(2) Follow the schedule for stops 40-fsw and deeper.

(3) Multiply the 30-, 20-, and 10-fsw stops by 1.5.

Table 8-3 summarizes the management of asymptomatic omitted decompression.

If a diver who blows up has any neurological symptoms, he should be compressed immediately in a recompression chamber. If he surfaced from 60 fsw or shallower, compress to 60 fsw and begin Table 6. If he surfaced from a greater depth, compress to 165 fsw and begin treatment on Table 6A. Symptoms developing during the surface interval or during a period of observation on no-decompression dives are treated as described in Paragraph 8-15.

If the blow up occurred from a depth of 165 feet or deeper and if the diver is not responding to recompression to 165 fsw, nonstandard treatment protocols as recommended by the Diving Medical Officer will have to be used in these cases and consultation with NEDU is appropriate. **IC 4**

Treatment of symptomatic divers who have surfaced unexpectedly, when no recompression.

If possible, a Diving Medical Officer should be consulted, before committing the patient to Table 4. If a diver is put on Treatment Table 4, the full 120 minutes should be spent at 165 feet unless operational or unforeseen medical considerations dictate earlier decompression.

If oxygen is available, the patient should begin oxygen breathing periods immediately upon arrival at the 60-foot stop. Breathing periods of 25 minutes on oxygen, interrupted by five minutes of air, are recommended because each cycle lasts 30 minutes. This simplifies timekeeping. Immediately upon arrival at 60 feet, a minimum of four oxygen breathing periods (for a total time of two hours) should be administered. After that, oxygen breathing should be administered to suit the patient's individual needs and operational conditions (Paragraph 8-15.4. 1). Both the patient and tender must breathe oxygen for at least four hours (eight 25-minute oxygen, 5minute air periods), beginning no later than two hours before ascent from 30 feet is begun. These oxygen breathing periods may be divided up as convenient, but at least two hours worth of oxygen breathing periods should be completed at 30 feet.

8-15.3.5 Treatment Table 7. Treatment Table 7 is considered a heroic measure for the treatment of non-responding severe gas embolism or life-threatening decompression sicknes s. Committing a patient to a Treatment Table 7 involves isolating the patient and having to minister to his medical needs in the recompression chamber for 48 hours or longer, and experienced medical and/or paramedical personnel should be on scene.

A Diving Medical Officer should be consulted, if possible, before shifting to a Treatment Table Seven, and careful consideration must be given to life support capability (Paragraph 8-15.5). In addition, it must be realized that the recompression facility will be committed for 48 hours or more. Consultation with a Diving Medical Officer shall be established as soon as possible.

Indications - Treatment Table 7 is an extension at 60 feet of Treatment Tables 6, 6A, or 4 (or any other nonstandard treatment table). This means that considerable treatment has already been administered. Treatment Table 7 is not designed to treat all residual symptoms that do not improve at 60 feet and should never be used to treat residual pain. Treatment Table 7 should be used only when the severity of the symptoms are such that marked residual impairment or loss of life may result if the currently prescribed decompression from 60 feet is undertaken.

Examples of conditions which would necessitate staying at 60 feet on Treatment Table 7 are: continued complete paralysis of limbs, coma, and/or loss of spontaneous respiration. Treatment Table 7 would probably not be used for: numbness, tingling, decreased sensation to touch (collectively termed paresthesias), limb weakness (as long as the patient can actually move the limb against gravity), or bladder problems without limb paralysis. These latter symptoms often respond to additional daily hyperbaric treatments (Paragraph 8-16.2). If patients have been improving at 60 feet, are conscious, breathe on their own, and can move their extremities against gravity, generally they should not be put on Treatment Table 7 unless deterioration in their condition is noted during decompression from 60 feet.

Extremely ill patients suffering from Type II decompression sickness or arterial gas embolism, who have had significant delays in starting recompression therapy (six to eight hours), may continue to deteriorate at depth. In these types of cases, Treatment Table 7 should be initiated if deterioration is still occurring at 60 feet. Because judgements as to whether a particular patient's condition warrants Treatment Table 7 will be difficult to make, additional consultation from NEDU should be obtained

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feet is preferable). Have the patient breathe 100-percent oxygen during transport, if available.

Tenders on Tables 5, 6, 6A, IA, 2A, or 3 should have a 12-hour surface interval before flying. Tenders on tables 4, 7 and 8 should not fly for 48 hours.

8-16.2 Treatment of Residual Symptoms. After completion of the initial recompression treatment, and after a surface interval sufficient to allow complete medical evaluation, additional recompression treatments may be instituted as prescribed by a Diving Medical Officer. For persistent Type II symptoms, daily treatment on Table 6 is preferred, but twice-daily treatments on Table 5 may also be used. Patients surfacing from Treatment Table 4, 7 or 8 may have severe pulmonary oxygen toxicity and may find breathing 100-percent oxygen at 60 feet uncomfortable. In these cases, daily treatments at 30 feet can be used. These treatments should be performed as prescribed by a Diving Medical Officer. As many oxygen breathing periods (25 minutes on oxygen followed by 5 minutes on air) should be administered as can be tolerated by the patient. Ascent to the surface is at one foot per minute. Three to four hours at 30 feet is a practical maximum bottom time. As tolerance to oxygen improves, Treatment Table 5 should be tried and, eventually Treatment Table 6, if indicated. Treatments should not be administered on a daily basis for more than five days without a break of at least one day. These guidelines may have to be modified by the Diving Medical Officer to suit individual patient circumstances and tolerance to oxygen.

Additional recompression treatments are indicated as long as they are prescribed by a Diving Medical Officer. In treating residual symptoms, no response to recompression may occur on the first one or two treatments. In these cases, the Diving Medical Officer is the best judge as to the number of treatments. Consultation with NEDU may be appropriate (phone numbers are listed at the beginning of Section 8C. As the delay time between completion of initial treatment and the beginning of follow-up hyperbaric treatments increases, the probability of benefit from additional treatments decreases. However, improvement has been noted in patients who have had delay times of up to one week. Therefore, a long delay is not necessarily a reason to preclude follow-up treatments. Once residual symptoms respond to additional recompression treatments, such treatments should be continued until no further benefit is noted. In general, treatment may be discontinued if there is no further sustained improvement on two consecutive treatments.

8-16.3 Returning to Diving after Treatment. Divers who meet all of the criteria for treatment using Treatment Table 5, as outlined in Paragraph 8-15.3.1, and who have had complete relief, may return to normal diving activity 48 hours after surfacing from the Treatment Table 5. If there is any doubt about the presence or absence of Type II symptoms, the diver should be examined by a Diving Medical Officer before resumption of diving.

Upon the recommendation of a Diving Medical Officer, divers who have had Type I symptoms requiring a Treatment Table 6 and who have had complete resolution of symptoms may resume normal diving activity on the seventh day following treatment.

Divers whose only Type 11 symptoms were patchy peripheral numbness, tingling and/or decreased sensation (collectively called patchy peripheral paresthesia), that resolved completely by the second oxygen breathing period at 60 feet, may resume normal diving activity 14 days following treatment, upon recommendation of a Diving Medical Officer.

Divers who had symptoms of arterial gas embolism or who have had any cardiorespiratory or neurological involvement other than patchy pe-

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ripheral paresthesia described above should not dive for at least four weeks and should resume diving only upon the recommendation of a Diving Medical Officer.

A diver having cardiorespiratory and/or CNS symptoms severe enough to warrant Treatment Table 4 or 7 should not dive for a minimum of three months, and not until a thorough review of his case by a Diving Medical Officer has established that return to normal diving activity can be accomplished safely.

8-17 NON-STANDARD TREATMENTS

The treatment recommendations presented in this chapter should be followed as closely as possible unless it becomes evident that they are not working. Only a Diving Medical Officer may then recommend changes to treatment protocols or use treatment techniques other than those described in this chapter. The standard treatment procedures in this chapter should be considered minimum treatments. Treatment procedures should never be shortened unless emergency situations arise which require chamber occupants to leave the chamber early.

8-17.1 Treatment of the Unconscious, Pulseless Diver. An unconscious diver without a pulse may be suffering from shock or cardiac arrest. Cardiac arrest (ventricular fibrillation) is a theoretical possibility in divers suffering from arterial gas embolism. It can also result from near drowning or electric shock. If a cardiac monitor and personnel trained in Advanced Cardiac Life Support (ACLS) are available, a stricken diver's electrocardiograph (EKG) should be monitored. If cardiac arrest is diagnosed, it should be treated appropriately prior to initiating recompression. If an EKG shows that cardiac arrest has not occurred, the appropriate recompression treatment should be started immediately.

If a cardiac monitor is not available and pulse is not detectable, a stricken diver may require ACLS when equipment and personnel become available. In such cases, a stricken diver should be recompressed to a depth of 60 fsw, while conducting BCLS. Do not go deeper than 60 fsw unless the pulse returns or a Diving Medical Officer has been consulted. Should a stricken diver remain unconscious with no detectable pulse and ACLS equipment and personnel become available, an attempt should then be made to verify if cardiac arrest has occurred.

Once cardiac arrest has been confirmed, appropriate ACLS procedures should be initiated. Recompression treatment should begin once cardiac arrest has been reversed. Specific procedures for combining ACLS with recompression treatment are not available and determining the appropriate treatment can only be done by personnel trained in diving medicine and ACLS. If a stricken diver does not respond to ACLS within 10 minutes, recompression treatment should be considered in order to determine if this will restore cardiac function. Consultation with NEDU should be made as quickly as possible in these situations.

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8-18 RECOMPRESSION TREATMENT ABORT PROCEDURES

Once recompression therapy is started, it should be completed according to the procedures in this chapter unless the diver being treated dies or unless continuing the treatment would place the chamber occupants in mortal danger.

If it appears that the diver being treated has died, qualified medical personnel must confirm the death before the treatment is aborted. If this is done, then the tenders may be decompressed by completing the treatment table, or by following the air decompression schedule (as modified below) for the total time since treatment began and the maximum depth attained. The shortest procedure should be used. The exception is Treatment Table 7. The appropriate abort proce-

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Emergency Assistance Checklist

RECOMPRESSION CHAMBER

Location

Name/Phone Number

Response Time

AIR TRANSPORTATION

Location

Name/Phone Number

Response Time

SEA TRANSPORTATION

Location

Name/Phone Number

Response Time

HOSPITAL

Location

Name/Phone Number

Response Time

DIVING MEDICAL OFFICER

Location

Name/Phone Number

Response Time

GAS SUPPLIES

Location

Name/Phone Number

Response Time

COMMUNICATIONS

Location

Name/Phone Number

Response Time

DIVING UNITS

Location

Name/Phone Number

Response Time

COMMAND

Location

Name/Phone Number

Response Time

EMERGENCY CONSULTATION

Duty Phone Numbers 24 Hours a Day

Navy Experimental Diving Unit (NEDU)
Commercial (850) 230-3100

Autovon 436-4351

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Figure 10-1. Emergency Assistance Checklist

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Unit (850) 230-3100 prior to deviating from standard saturation decompression procedures.

12-23.2.1 Emergency Abort Procedure. An Emergency Abort Procedure should only be conducted for grave casualties that are time critical. Decompression times and chamber oxygen partial pressures for emergency aborts from helium-oxygen saturation are shown in Table 12-9.

Emergency Abort decompression is begun by making the maximum Upward Excursion allowed by Table 12-7. Rate of travel should not to exceed 2 fsw/min. The upward excursion includes a two hour hold at the upward excursion limit. Travel time is included as part of the 2 hour hold. Following the Upward Excursion, the chamber oxygen partial pressure is raised to the value shown in Table 12-9. Decompression is begun in one-foot increments using the times indicated in Table 12-9. Rate of travel between stops is not to exceed 1 fsw/minute. Travel time is included in the next stop time. The partial pressure of oxygen is controlled at the value indicated until the chamber oxygen concentration reaches 23 percent. The oxygen concentration is then controlled between 19 and 23 percent for the remainder of the decompression. Stop travel at 4 fsw until total decompression time has elapsed and then travel to the surface at 1 fsw/ minute.

For example, the maximum depth of the diver in the last 48 hr was 400 fsw, and the Commanding Off icer approves the use of the Emergency Abort Procedure. From the Upward Excursion Table, the complex travels to 307 fsw at a rate not to exceed 2 fsw/min. It takes 46.5 min to travel. This time is part of a 2 hr hold requirement as part of the upward excursion.

Since the post-excursion depth is between 2731000 fsw, the chamber oxygen partial pressure is raised to 0.6 ata. Once the atmosphere is established and the remainder of the 2 hr hold completed, begin decompression in one-foot increments with stop times of 12 min from 307 to 200 fsw. The travel rate between stops should not exceed I fsw/min. Travel time is included in the stop time. It will take 21.4 hr to arrive at 200 fsw.

At 200 fsw the one-foot stop time changes to 21 min. It will take 70 hours to reach the surface. The total decompression time is 93.4 hours (3 day 21 hours 21 minutes 36 seconds). By contrast standard saturation decompression would take approximately 4 days, and 3 hours to complete.

During and following the dive, the divers should be monitored closely for signs of decompression sickness and for signs of pulmonary oxygen toxicity. The latter includes

Table 12-9. Emergency Abort Decompression Times and Oxygen Partial Pressures

Post Excursion Depth (fsw)	ppO_2(ata)	One-Foot Stop Time (min)	
		1000-2000 fsw	200-0 fsw
0-203	0.8	11	18
204-272	0.7	11	19
273-1000	0.6	12	21